



Modeling & Simulation Environmental Representations Plans & Programs

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MSEA Mission

The Under Secretary of Defense for Acquisition & Technology (USD(A&T)) has designated Modeling & Simulation Executive Agents (MSEAs) for authoritative representation of the natural environment :

**To enable
developers and users
to represent the natural environment
rapidly, thoroughly, and consistently
in a manner that promotes
cost-effectiveness, ready access, interoperability, re-use,
and confidence.**

MSEA Principals

Terrain

Director,
National Imagery and
Mapping Agency (NIMA)

Chief,
RDT&E
Division (SR)
Systems & Technology
Directorate (ST)

Chief,
Terrain Modeling
Project Office
(TMPO)

Oceans

Oceanographer
of the Navy
(N-096)

Technical
Director
(N-096)

Program Manager,
Ocean
Executive Agent
(OEA)

Air/Space

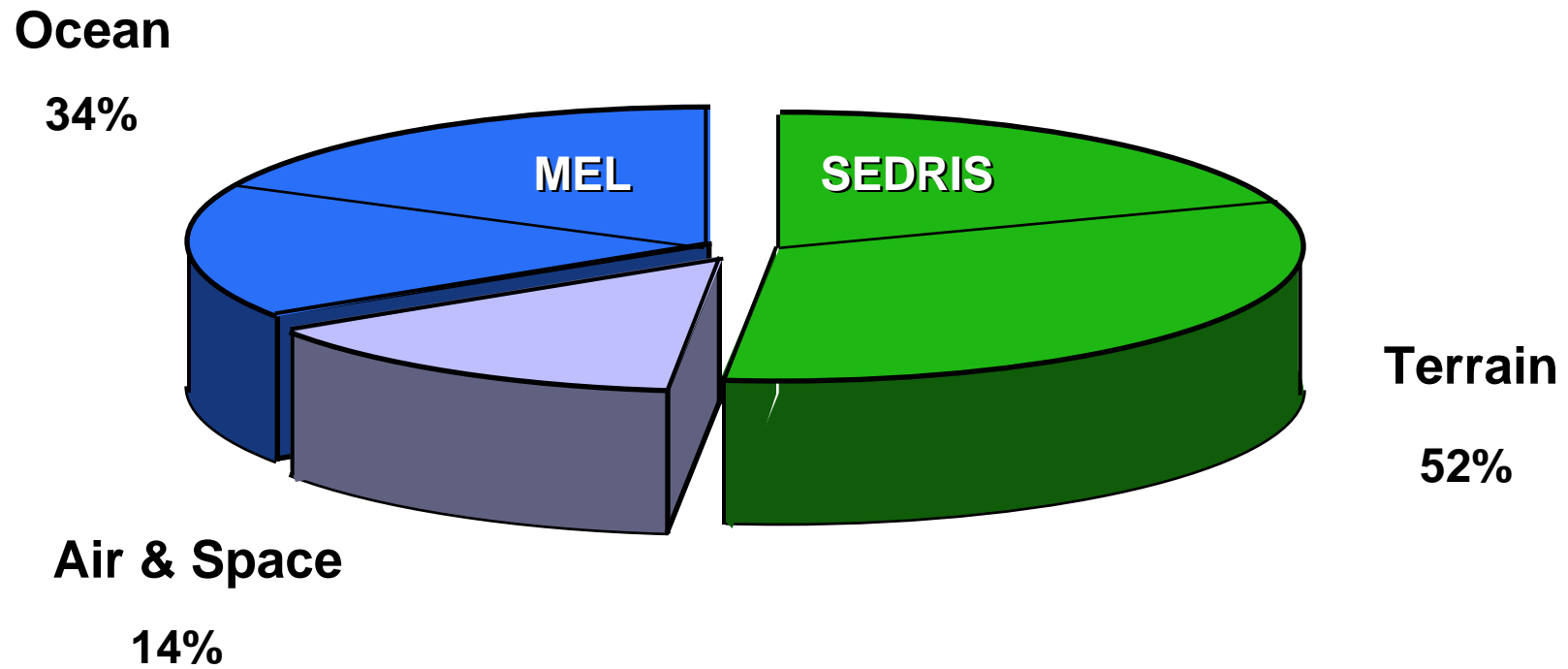
USAF
Director of Weather
(XOW)

Commander,
Air Force Combat
Climatology Center
(AFCCC)

Chief,
M&S Division
(AFCCC)



FY 97 Joint Environmental Program



"LAWS" of M&S Database Design

You can never get all the data you need (or desire)

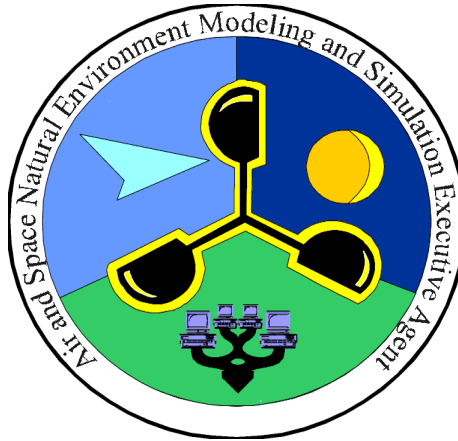
You can never use all the data you get

You design your simulation around the available data

- but -

The MSEAs are working to eliminate these "laws"

MSEA for Air & Space



Lt Col John M. Lanicci, USAF

HQ USAF Directorate of Command and Control

representing the

Modeling & Simulation Division

Air Force Combat Climatology Center

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Space Weather Effects on Satellite Systems / Subsystems

- **Research Objective:** Develop computer simulation capability needed for assessing the impact of space weather on satellite system / subsystems that are or will be deployed in the near-earth space environment
- **Technology Challenges:**
 - Providing capabilities to tie satellite sensor, communication link, and navigation link effects models to relevant space environment models in GEOSpace
 - Extending a microchip single event upset rate predictor using cosmic ray input to include energetic protons in the radiation belt
 - Providing GEOSpace capability to other M&S systems

Space Weather Effects on Satellite Systems / Subsystems

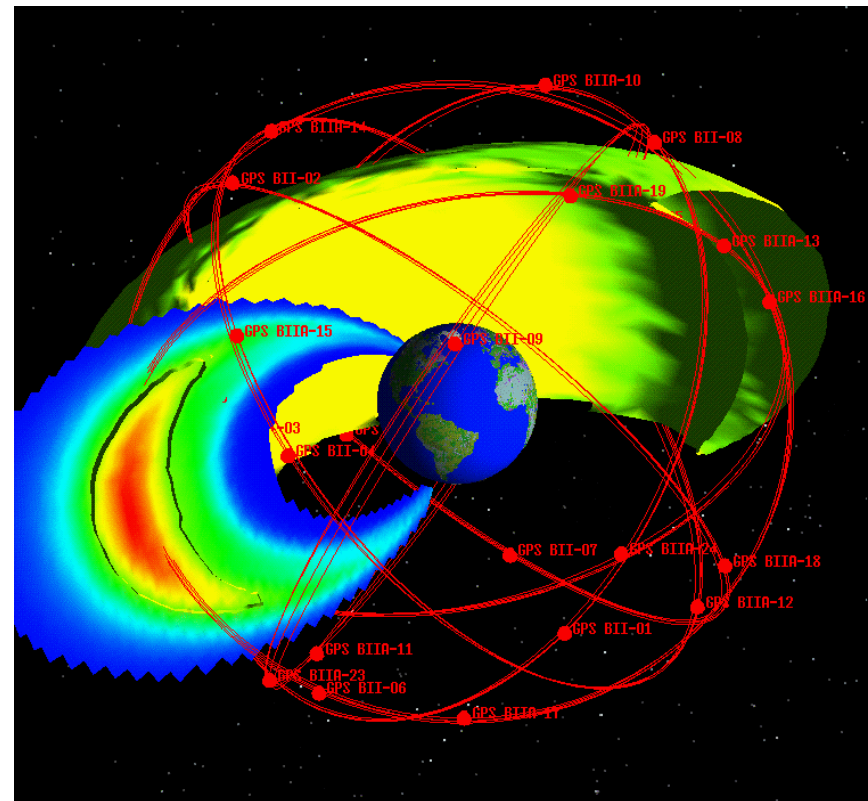
- **Approach:**
 - **Utilize existing space models**
 - **GEOSpace**
 - **Spacecraft Simulation Toolkit (SST)**
 - **Space and Missile Analysis Tool (SMAT)**
 - **Construct a satellite object in GEOSpace that allows a user to specify look directions and solid angles, and communication links**
 - **Modify single event upset algorithms to accept proton and heavy ion fluxes**
 - **Transform particle probability to optical background probability**
 - **Couple SMAT and SST models to GEOSpace effects modules**

Space Weather Effects on Satellite Systems/Subsystems

- **Significance:** The resulting space weather effects simulation system will provide capabilities to many M&S customers across DoD
 - **Engineering and acquisition communities will use it to design next-generation satellites**
 - **Constructive simulations will be provided with realistic impacts caused by degraded satellite operations**
 - **Training simulations will be provided with a more realistic representation of how space weather impacts satellite communications, detection, etc.**
- **Performer: U.S. Air Force Phillips Laboratory**

Space Weather Effects on Satellite Systems/Subsystems

- GEOSpace can currently provide products such as one shown here that specifies the 2 Mev electron flux levels in the GPS orbital region
- This model will be made more dynamic by having the electron belts move in response to solar events



High Resolution Gridded Climatology

- **Research Objective**

- **Develop capability to produce hourly, annual climate statistics for temperature, pressure, wind, and moisture at 10 km spatial resolution for 800 x 800 km regions.**
- **Develop climate statistics for other derived variables (clouds, visibility, icing, etc.)**

- **Technology Challenges:**

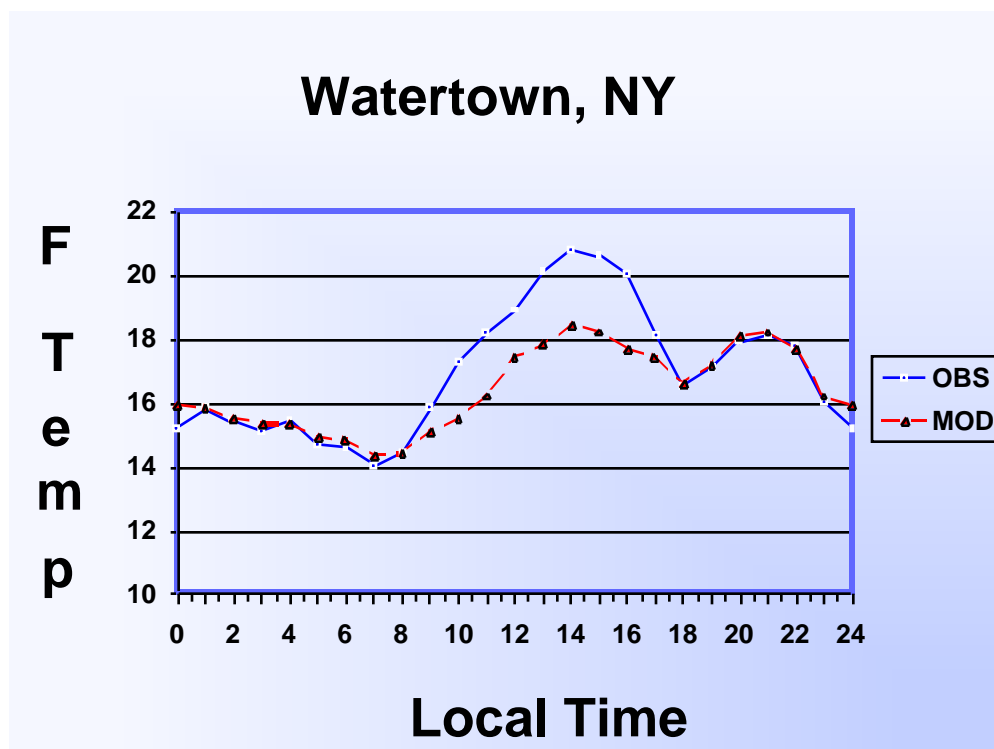
- **Method to composite observational and model-generated data**
- **Automated procedure to assess quality of climatological datasets**
- **4-D data assimilation system that is computationally manageable**
- **Algorithms for calculating derived variables**

High Resolution Gridded Climatology

- **Approach: Develop basic climatology using Mesoscale Atmospheric Simulation System (MASS) numerical model**
 - **Determine value of adding actual observations**
 - **Develop climate statistics for two regions:**
 - **Korea**
 - **Middle East**
 - **Determine feasibility of adapting system to provide 30, 60, 90, 120 day climate forecasts**
 - **Refine climatologies using statistical methods**
 - **remove biases**
 - **provide 1 km resolution data**

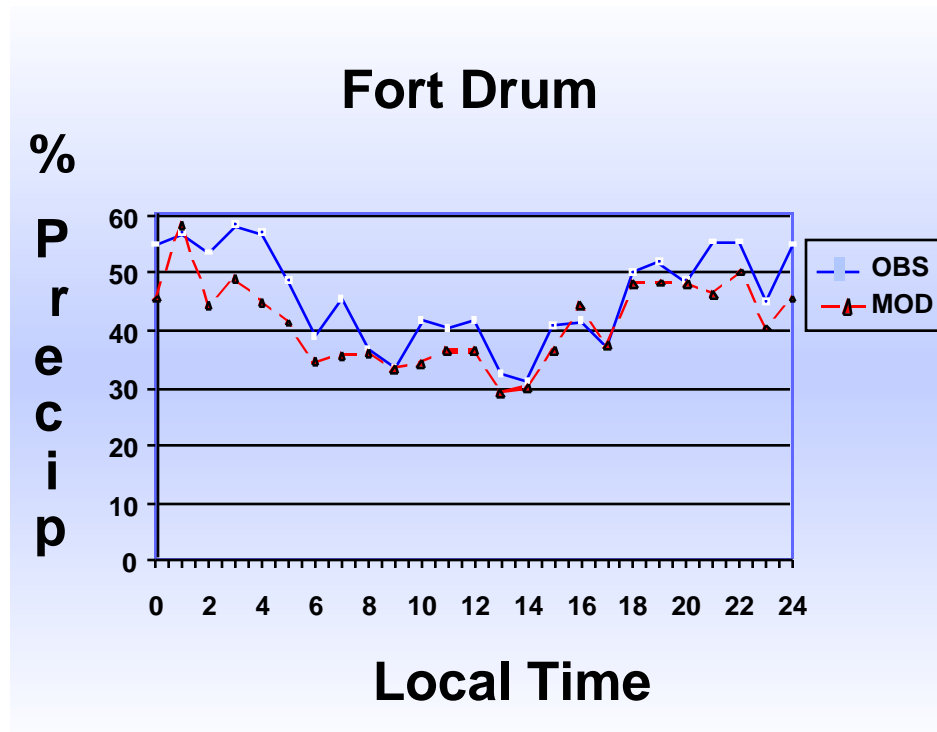
Preliminary Results of Model Statistics

Temperature Observations vs Model



Preliminary Results of Model Statistics

Precipitation Observations vs Model



High Resolution Gridded Climatology

- **Significance :**
 - **Provide an efficient method for producing high resolution gridded climatology**
 - **More realistic and higher fidelity Intelligence Preparation of the Battlefield (IPB), mission rehearsal and planning, training, and engineering and acquisition simulations**
 - **Joint M&S programs such as JWARS, JSIMS, and JMASS need this capability.**
- **Performers:**
 - **Air Force Combat Climatology Center**
 - **St. Louis University**
 - **Meso Inc.**
 - **U.S. Air Force Phillips Laboratory**

Tri-Service Laboratory Consortium

- **Research Objective:** Establish a partnership among DoD labs that can efficiently blend the R&D efforts of the three Services to develop optimum M&S solutions for the joint M&S programs.
- **Technology Challenges and Organizational Issues:**
 - Developing new approaches to problems
 - Optimal use of resources under budget constraints
 - M&S technology rapidly changing
 - Networked M&S system complexity
 - Demand for more sophisticated environmental representations

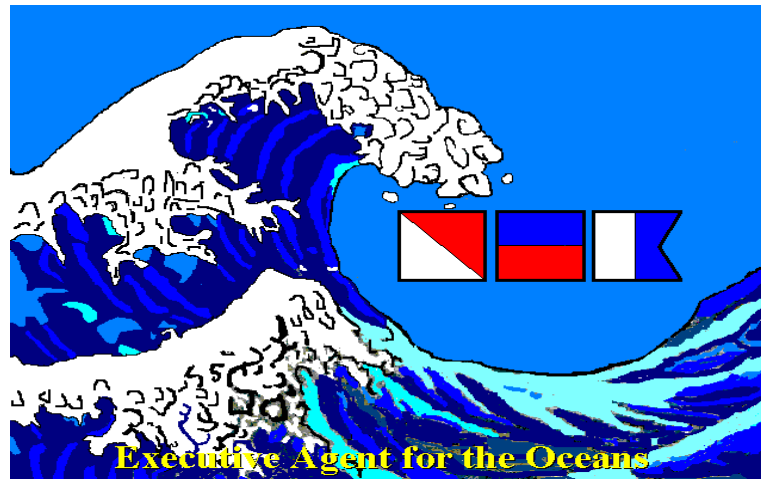
Tri-Service Laboratory Consortium

- **Approach:**
 - **Develop action plan describing how to best leverage and coordinate DoD lab resources**
 - **Conduct regularly scheduled workshops**
 - ♦ **to exchange ideas**
 - ♦ **to gain better appreciation of each lab's capabilities**
 - ♦ **to learn more about customer needs**
 - **Develop cooperative R&D programs addressing technical shortfalls**

Tri-Service Laboratory Consortium

- **Significance:**
 - **Prevents duplication of M&S efforts**
 - **Better enables labs to develop models that are interoperable and reusable**
 - **Better focuses DoD lab M&S resources**
 - **Provides MSEA with more direct access to lab expertise**
- **Performers:**
 - **U.S. Air Force Phillips Laboratory**
 - **U.S. Army Research Laboratory**
 - **Naval Research Laboratory - Monterey**

MSEA for Ocean



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RApid Generation Littoral EnvironmentS RAGLES



RApid Generation Littoral EnvironmentS RAGLES

- **Research Objective:**

- **Combine existing numerical models with state-of-the-art assimilation / fusion methods into a tested and documented system which can rapidly generate required environmental data for modeling and simulation**

- **Technology Challenges:**

- **Little or no reliable environmental information exists today for most coastal areas outside the US**
- **Established procedures do not exist to produce reliable data bases from available models and observations**

RApid Generation Littoral EnvironmentS RAGLES

Approach:

- **Assemble predictive system for an area of interest**
 - Numerical models
 - Include in situ satellite data sets
 - Test data assimilation methods
- **Integrate remote sensing data (satellite and aircraft)**
- **Test and evaluate system performance**
- **Develop output routines for data bases**
- **Document all procedures for RAGLES**
- **Provide access to RAGLES through MEL (Master Environmental Library)**

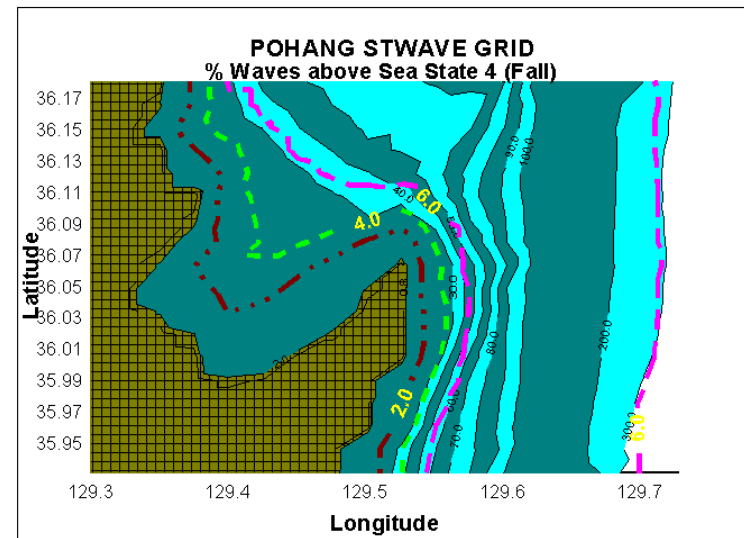
RApid Generation Littoral EnvironmentS

RAGLES

Results:

- **RAGLES is capable of generating detailed wind, wave, and water level information**
 - Previous assumptions concerning sheltering are significantly incorrect
- **RAGLES incorporates numerical, model, satellite, and in situ data**
 - Improved algorithm for satellite wave estimates

Contours of Exceedance



RApid Generation Littoral EnvironmentS RAGLES

- **Significance:**
 - **Methodology provides vastly improved data bases for important areas of operation**
 - **Methodology will provide the capability to rapidly produce consistent littoral representations for any coastal region**
- **Transition:**
 - **Improved littoral environment data bases have been requested by PACOM for operational planning (LOTS)**
 - **Improved littoral environmental data bases are being transitioned to relevant simulation models within DoD (LOTS)**
 - **Procedures, methodology, and prototype test data bases will be documented with access provided through MEL (DMSO)**

Joint Distributed Surf Zone Environmental System

- **Research Objective:**
 - Develop procedures for generating surf zone environmental representation
 - Develop procedures to generate the environmental effects on surf zone platforms and sensors
- **Technology Challenge:** Establishing a complete, efficient, and consistent methodology for representing surf zone complexity



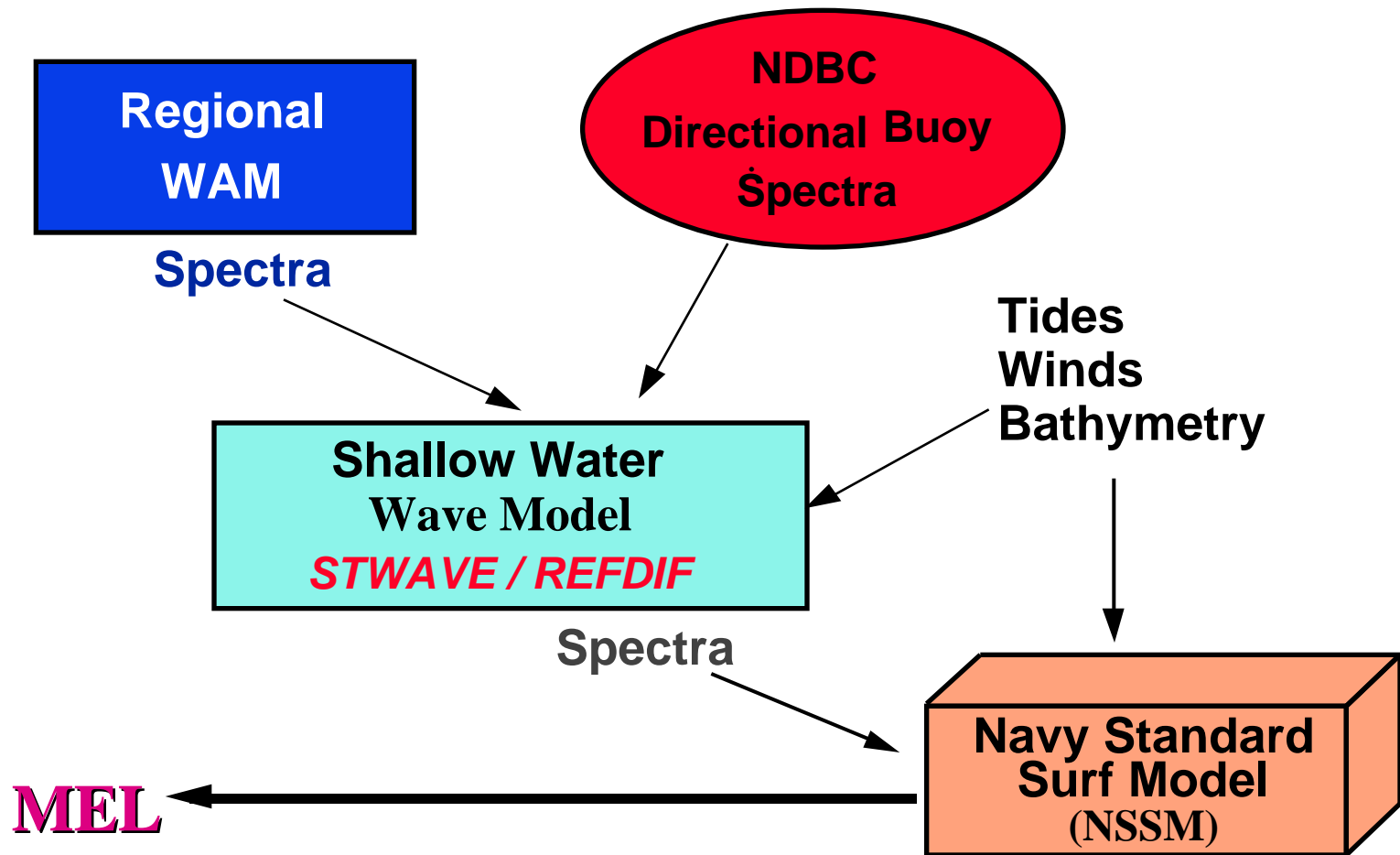
Joint Distributed Surf Zone Environmental System

- **Approach:**
 - **Identify available numerical models and input data requirements**
 - **Design linked algorithms to produce parameters for the surf zone model**
 - **Prepare environmental parameters for the surf zone model**
 - **winds**
 - **tides**
 - **beach profiles**
 - **wave spectra**
 - **Obtain and encode data for ocean wave and ocean circulation models**
 - **Integrate all components**
 - **Provide results to M&S users**

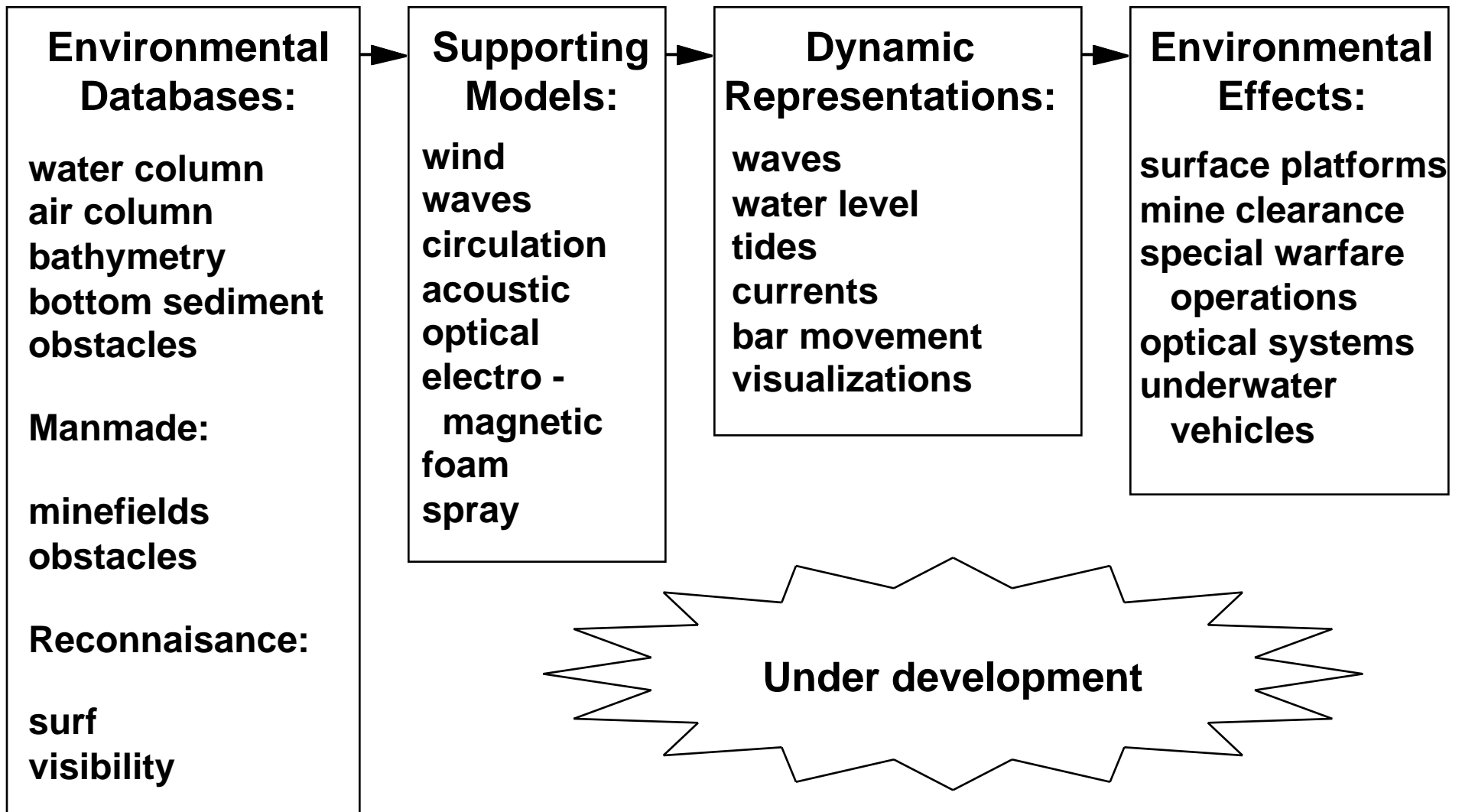
Joint Distributed Surf Zone Environmental System

- **Results:**
 - Documented procedures to calculate various surf zone processes
 - Report on optimum approach and requirements
 - Work started on surf zone model
 - GRIB / BUFR formatted ocean wave and ocean circulation data for two areas
- **Significance:**
 - Step-by-step procedures used to prepare input data, run models, and evaluate results
 - Explosive technology included in the surf zone
 - A time dependent surf zone environmental representation model targeted for use in the Explosive Advanced Technical Development Project

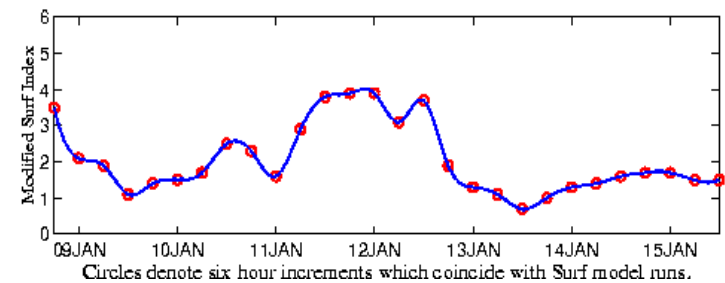
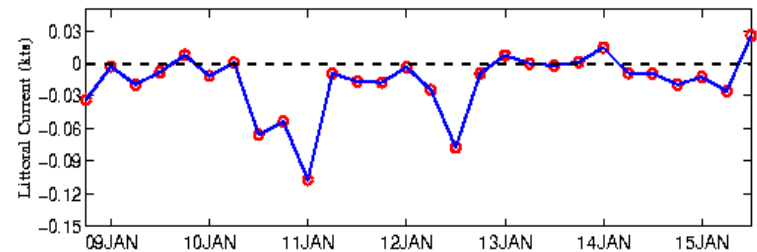
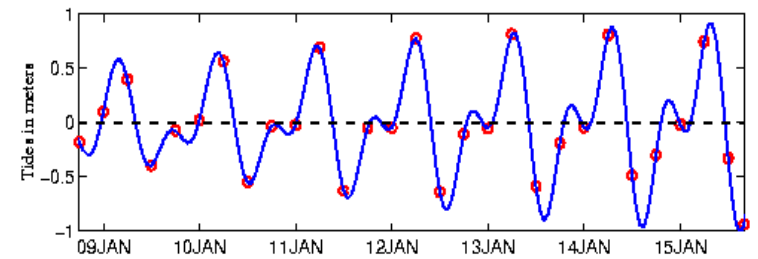
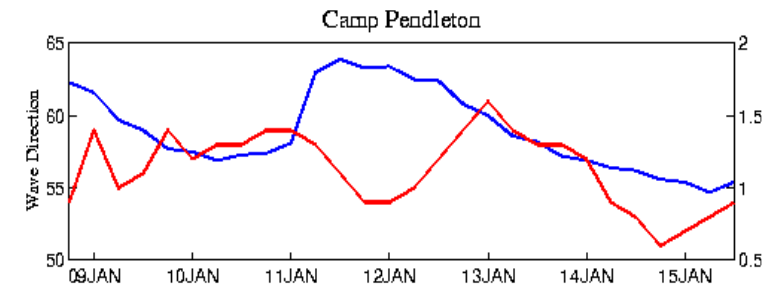
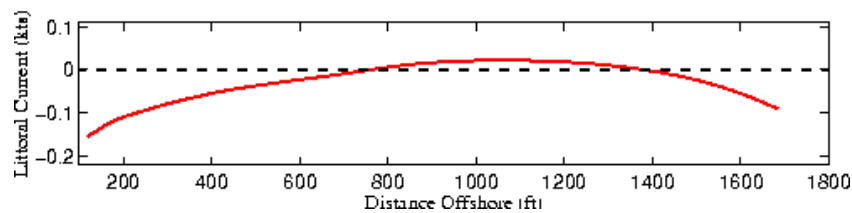
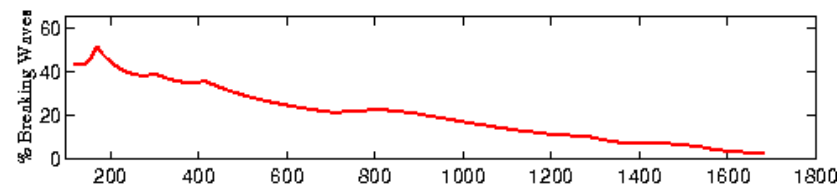
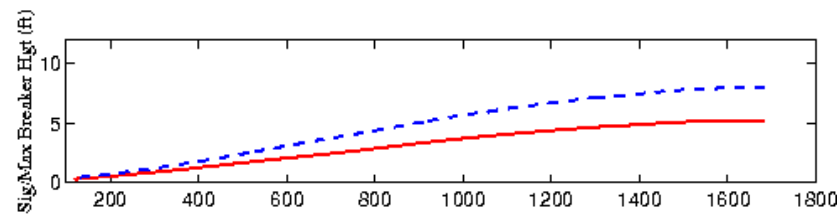
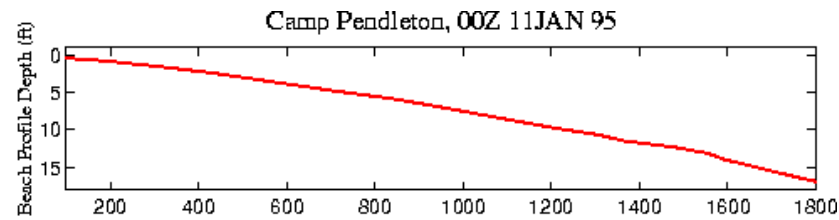
Surf Zone Modeling Procedure



Joint Distributed Surf Zone Environmental System



Surf Zone - Dynamic Environment



Circles denote six hour increments which coincide with Surf model runs.

MSEA for Terrain



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M&S Terrain Definition

- Terrain representation includes:
 - **the configuration, composition, and representation of the surface of the earth**, its relief, natural features, permanent or semi-permanent man-made features, and related processes.
 - **terrain coverage** involving seasonal and diurnal variation such as grasses and snow, foliage coverage, tree type, and shadow.
 - the terrain surface plus inland waters, and the sea floor bottom to the 10 meter depth curve.
 - **the mutual interaction of dynamic phenomena and the terrain.**

DoD Modeling and Simulation (M&S) Master Plan, DoD 5000.59-P, October 1995

Terrain M&S Data

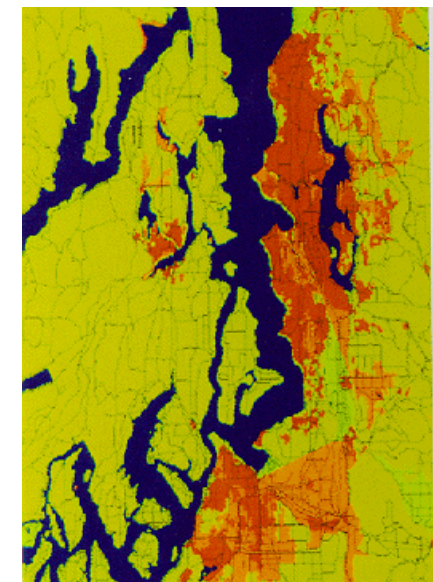
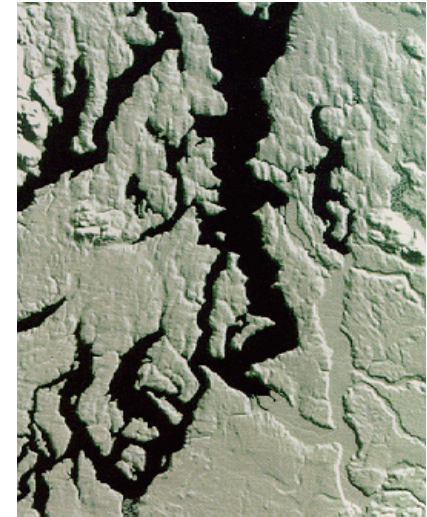
- **Topology / Geometry**

- Elevation map (DTED 0 - 5)
- 3-D models (e.g., buildings, bridges, vehicles)
- **Fine and coarse scale roughness**
- **Material thickness and orientation**
-

- **Attributes (FACC with extensions)**

- **Parameter libraries**

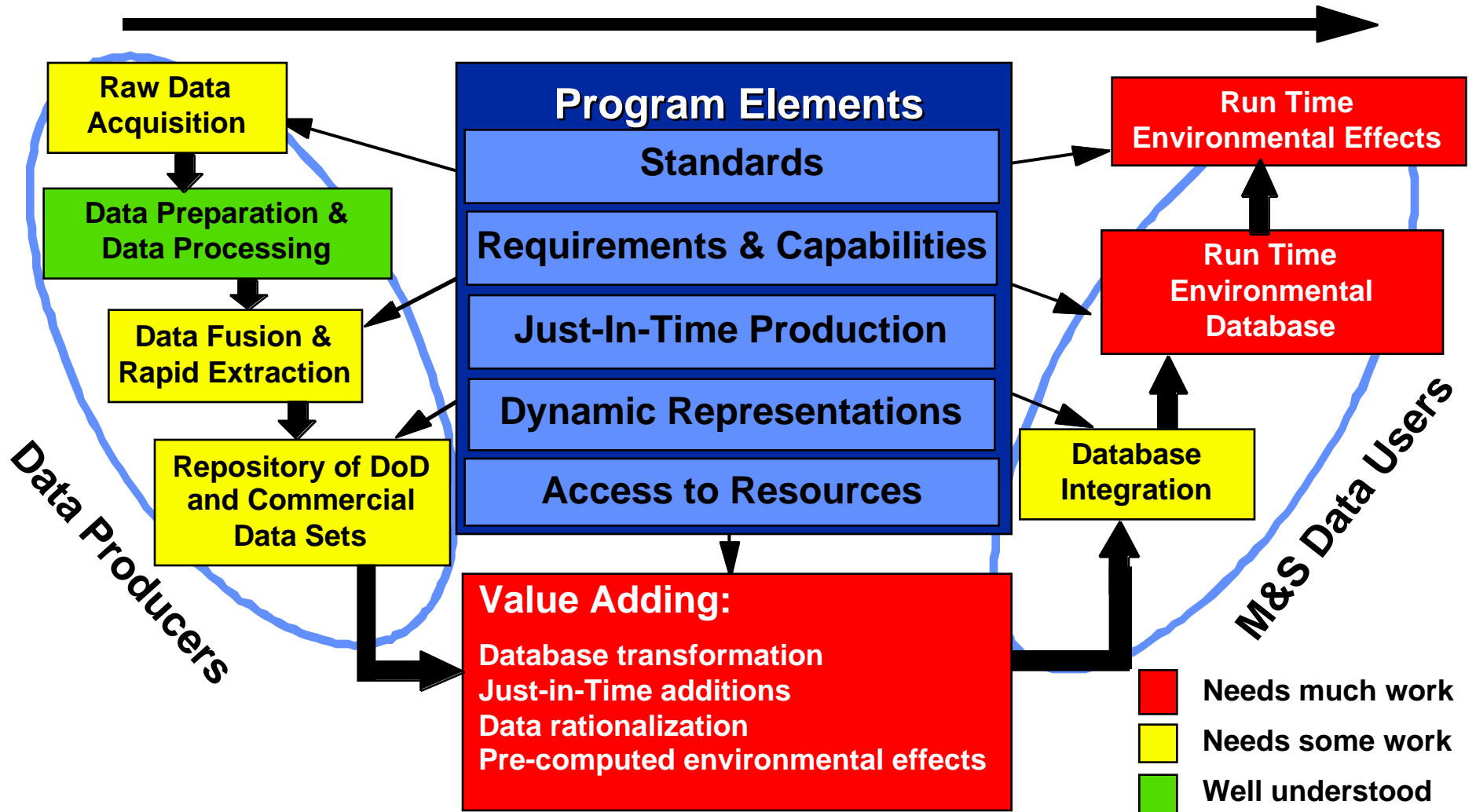
- **Temporal variations (e.g., snow / ice, seasonal)**
- **Thermal properties (e.g., specific heat)**
- **Optical properties (e.g., reflectivity)**
- **Radar / lidar properties (e.g., backscatter)**
- **Textures / texture maps / modulations**



Generating M&S Databases

1996: Weeks/Months

2000 + : Hours/Days



Standards

- **Activities:**

- **Data Dictionary**
- **VV&A/VV&C Projects**
- **Enhanced VPF profile to support M&S**
- **Environmental data interchange specification (SEDRIS)**

- **Target Accomplishments:**

- **Accepted standards to promote interoperability and reuse**
- **More consistent and cost effective exchange of environmental data**
- **Determine feasibility of VPF as baseline for SEDRIS**
- **Extend SEDRIS to include large volume gridded data fields**
- **Give the M&S community an extended family of VPF products with an expanded DoD Data Dictionary**

Requirements & Capabilities Analysis

- **Activities:**

- High resolution terrain support & analysis
- Academic research BAA
- Terrain prototype & test environment for M&S
- SE development process definition

- **Target Accomplishments:**

- Extensive field visits to customers
- Finalize prototype high-resolution MOBA data sets
- Facilitate definition of requirements by M&S developers and users
- Identify and plan for addressing capability shortfalls
- Establish user-accessible global M&S environment requirements and capabilities database
- Establish teamwork across service laboratories
- Effective MSEA advocacy of developer and user M&S requirements to data producers
- Improved subject matter expertise

Just-in-Time Production

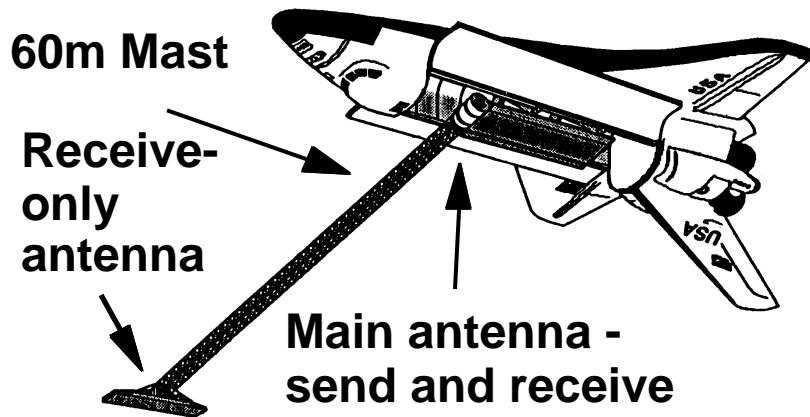
- **Activities:**

- **Auto feature extraction & integrated triangulated irregular network process development**
- **Rapid extraction of elevation and feature data**
- **Commercial terrain extraction prototype**
- **Commercial multi-sensor source**
- **Commercial hyper-spectral imagery feature extraction**
- **Improved terrain database construction**
- **Shareware image generator development**

- **Target Accomplishments:**

- **4 times faster terrain database processing time**
- **50 times faster automated elevation / feature extraction**
- **Commercial capability catalog provided to users**
- **Prototype data sets generated and evaluated for process and product specification**

Shuttle Radar Topography Mission (SRTM)



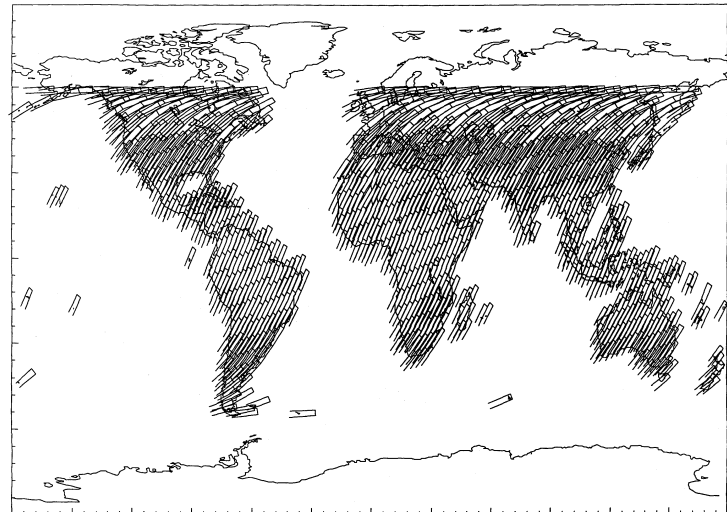
Launch date: May 2000
System ready: March-May 1999
Processing time: 12 months

Interferometric SAR system

- C-band Interferometric SAR based on SIR-C
- Terrain height data (DTED 2)
- SAR image (30 meter pixel)
- **Terrain classification overlay (urban, water, vegetation, forest)**

Joint DoD (NIMA) / NASA (JPL) mission

- DTED 1 and CONUS DTED 2 Releasable; OCONUS DTED 2 TBR
- Images between 60° N and 56° S
- Captures 80% of Earth land mass
- Dual coverage - ascending and descending passes; altitude 227 km; 57° inclination



Dynamic Representation

◆ Activities:

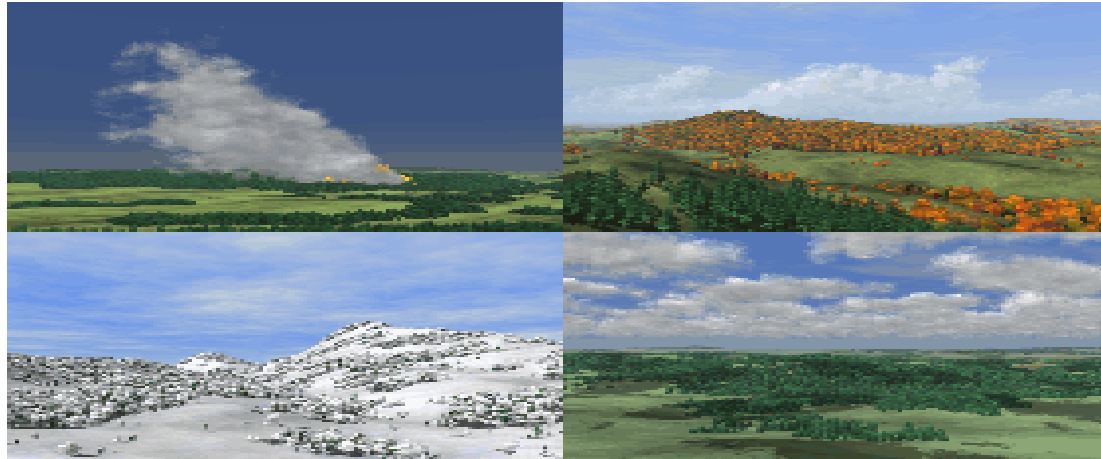
- Dynamic agents / mobile objects (DYNAMO)
- Dynamic terrain and structures

◆ Target Accomplishments:

- Issues identification and lessons learned
- Reference implementations available for customer consideration
- Make reusable dynamic algorithms and tools available to M&S developers

Dynamic Terrain

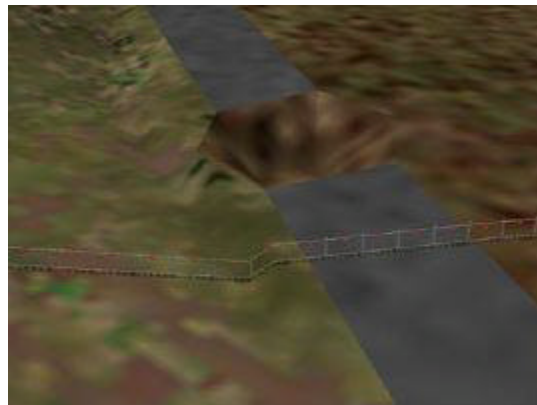
Natural Changes



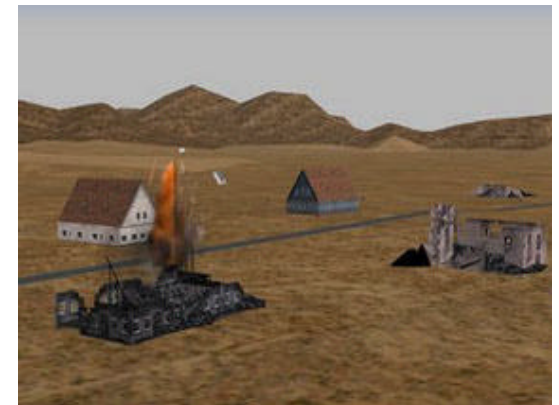
Military Operations



Obstacles



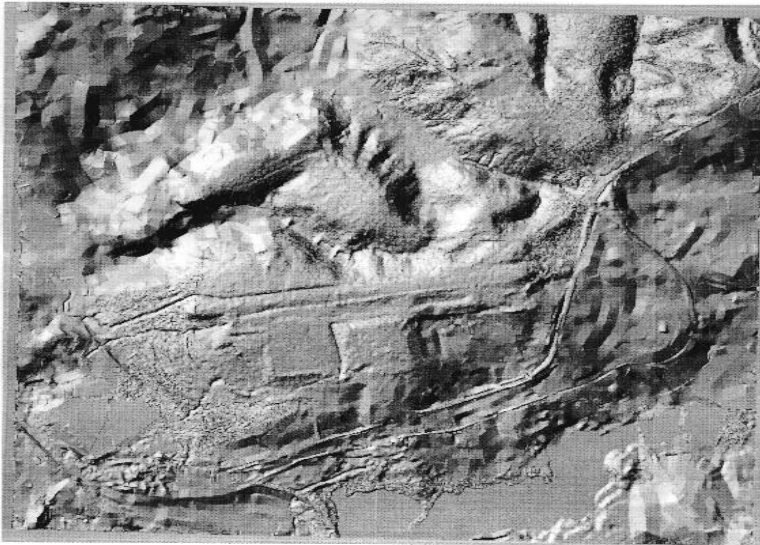
Cratering



Damaged Buildings

High Resolution Data -1 meter

UNCLASSIFIED



FORT BENNING - TEC MER LV5

- Absolute / relative accuracy
- Fidelity in capture of micro terrain



1 meter

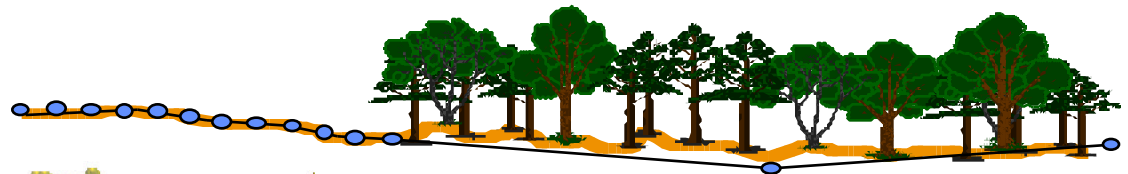


3 meter



10 meter

- Fidelity under the canopy



Fort Benning, GA
McKenna MOUT site

Tell me more

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http://www.dmsomil/ocean_ea/OceanHome.html